CLAIMS

What is claimed is:

1. A positive electrode for a lithium sulfur battery comprising:

a positive active material with a particle size D (v, 50%) of approximately 10 μm or less, the positive active material being selected from the group consisting of elemental sulfur (S_8), a sulfur-based compound, and a mixture thereof.

2. The positive electrode of claim 1, wherein the particle size D (v, 50%) of the positive active material is approximately 1 to 5 μm.

3. The positive electrode of claim 1, wherein the positive electrode has an average surface roughness Ra of approximately 5 μm or less before assembly of the battery.

4. The positive electrode of claim 3, wherein the positive electrode has an average surface roughness Ra of approximately 0.1 to 5 μm before assembly of the battery.

5. The positive electrode of claim 4, wherein the positive electrode has an average surface roughness Ra of approximately 0.2 to 4 μm before assembly of the battery.

6. The positive electrode of claim 1, wherein the sulfur-based compound is selected from the group consisting of Li_2S_n($n \geq 1$), Li_2S_n ($n \geq 1$) in catholyte, an organo-sulfur compound, and a carbon-sulfur polymer ($(C_2S_x)_n$: $x = 2.5$ to 50, $n \geq 2$).

7. A positive electrode for a lithium sulfur battery having an average surface roughness Ra of approximately 5 μm or less before assembly of the battery.

8. The positive electrode of claim 7, wherein the positive electrode has an average surface roughness Ra of approximately 0.1 to 5 μm before assembly of the battery.

9. The positive electrode of claim 8, wherein the positive electrode has an average surface roughness Ra of approximately 0.2 to 4 μm before assembly of the battery.

10. A lithium sulfur battery comprising:

a positive electrode comprising a positive active material with a particle size D (v, 50%) of approximately 10 μm or less, the positive active material being selected from the group consisting of elemental sulfur (S_8), a sulfur-based compound and a mixture thereof;

a negative electrode comprising a negative active material selected from the group consisting of a material in which lithium intercalation reversibly occurs, a material that reacts with lithium ions to form a lithium-containing compound, a lithium metal, and a lithium alloy; and

an electrolyte.

11. The lithium sulfur battery of claim 10, wherein the positive electrode of claim 1, wherein the particle size D (v, 50%) of the positive active material is approximately 1 to 5 μm.

12. The lithium sulfur battery of claim 10, wherein the positive electrode has an average surface roughness Ra of approximately 0.1 to 5 μm before assembly of the battery.

13. The lithium sulfur battery of claim 12, wherein the positive electrode has an average surface roughness Ra of approximately 0.2 to 4 μm before assembly of the battery.

14. The lithium sulfur battery of claim 10, wherein the positive electrode has an average surface roughness Ra of approximately 0.1 to 15 μm in a central portion after a cycle life test of the battery is done.

15. The lithium sulfur battery of claim 14, wherein the positive electrode has an average surface roughness Ra of approximately 0.1 to 8 μm in the central portion after a cycle life test of the battery is done.

16. The lithium-sulfur battery of claim 10, wherein the central portion is a portion corresponding to 60% with an exception of right and left 20% portions, when a total longitudinal direction length of the positive electrode is 100%, and the central portion does not include a folded portion where an electrode is wound.

17. The lithium sulfur battery of claim 14, wherein the cycle life test is performed by charging at 0.1 to 2.0 C and by discharging at 0.1 to 2.0 C.

18. The lithium sulfur battery of claim 17, wherein the cycle life test is performed by charging at 0.2 to 1.0 C and by discharging at 0.2 to 2.0 C.

19. The lithium sulfur battery of claim 14, wherein the cycle life test is performed at a charge rate of 0.1 to 2.0 mAh/cm^2 and at a discharge rate of 0.2 to 1.0 mAh/cm^2.

20. The lithium sulfur battery of claim 14, wherein the cycle life test is performed by charging and discharging for 1 to 100 times.

21. The lithium sulfur battery of claim 20, wherein the cycle life test is performed by charging and discharging for 5 to 100 times.

22. The lithium sulfur battery of claim 21, wherein the cycle life test is performed by charging and discharging for 5 to 20 times.

23. The lithium sulfur battery of claim 14, wherein the battery is presented in a condition of charge or discharge after the cycle life test is done.

24. The lithium sulfur battery of claim 14, wherein the battery is presented in a condition of being charged or being discharged after the cycle life test is done.

25. The lithium sulfur battery of claim 14, wherein the battery has an open circuit voltage of 1.0 to 4.5 V after the cycle life test is done.

26. The lithium sulfur battery of claim 25, wherein the battery has an open circuit voltage of 1.5 to 3.0 V after the cycle life test is done.

27. The lithium sulfur battery of claim 14, wherein the positive active material is presented in an area of 10 to 90% based on a total area in the positive electrode after the cycle life is done.

28. The lithium sulfur battery of claim 27, wherein the positive active material is presented in an area of 20 to 80% based on the total area in the positive electrode after the cycle life is done.

29. The lithium sulfur battery of claim 28, wherein the positive active material is presented in an area of 30 to 70% based on the total area in the positive electrode after the cycle life is done.

30. The lithium sulfur battery of claim 10, wherein the sulfur-based compound is selected from the group consisting of Li_2S_n($n \geq 1$), Li_2S_n ($n \geq 1$) in catholyte, an organo-sulfur compound and a carbon-sulfur polymer ($(C_2S_x)_n$: x= 2.5 to 50, $n \geq 2$).

31. The lithium sulfur battery of claim 10, wherein the positive electrode further comprises a coating layer, the coating layer comprising a polymer, an inorganic material or a mixture thereof.

32. The lithium sulfur battery of claim 31, wherein the polymer is selected from the group consisting of polyvinylidene fluoride, a copolymer of polyvinylidene fluoride and hexafluoropropylene, poly(vinyl acetate), poly(vinyl butyral-co-vinyl alcohol-co-vinyl acetate), poly(methylmethacrylate-co-ethyl acrylate), polyacrylonitrile, polyvinyl chloride-co-vinyl acetate, polyvinyl alcohol, poly(1-vinylpyrrolidone-co-vinyl acetate), cellulose acetate, polyvinyl pyrrolidone, polyacrylate, polymethacrylate, polyolefin, polyurethane, polyvinyl ether, acrylonitrile-butadiene rubber, styrene-butadiene rubber, acrylonitrile-butadiene styrene, a sulfonated styrene/ethylene-butylene/styrene triblock copolymer, polyethylene oxide, and a mixture thereof.

33. The lithium sulfur battery of claim 31, wherein the inorganic material is selected from the group consisting of colloidal silica, amorphous silica, a surface-treated silica, colloidal alumina, amorphous alumina, conductive carbon, tin oxide, titanium oxide, vanadium oxide, titanium oxide, zirconium oxide, iron oxide, iron sulfide, iron titanate, barium titanate, and a mixture thereof.

34. A method of producing a positive electrode of a lithium sulfur battery, comprising:

pulverizing S_8 powder in an isopropylalcohol solvent for approximately 72 hours, and drying a resulting material at approximately 80°C for approximately 1 hour to prepare a positive active material;

mixing 60 wt% of the positive active material, 20 wt% of a carbon conductive agent, and 20 wt% of a polyvinylpyrrolidone binder uniformly in an isopropyl alcohol solvent to form a slurry;

coating the slurry was on a carbon-coated Al current collector; and

drying the coated collector at room temperature for approximately 2 hours, and again drying the coated collector at approximately 50°C for approximately 12 hours to produce the positive electrode.

35. The method of claim 34, wherein pulverizing the S_8 powder is performed for approximately 48 hours.

36. The method of claim 34, wherein pulverizing the S_8 powder is performed for approximately 24 hours.